

Application Serial No. 10/531,218
Reply to Office Action July 31, 2009

PATENT
Docket CU-4148

Amendments to the Specification

In the specification, please amend ¶¶[0013]-[0017] as follows:

[0013] The objects of the present invention described above are achieved by a method of manufacturing a weight-saved gypsum board in which pores with a predetermined size are distributed in a gypsum core, including the steps of blowing air into a foaming agent to produce ~~foams~~a foam having bubbles, mixing the foam having bubbles ~~foams~~ into a kneaded material that contains calcined gypsum and water to obtain foamed gypsum slurry, pouring the foamed gypsum slurry into a space between upper and lower base papers for gypsum board, shaping the base papers and the foamed gypsum slurry into a board shape, roughly cutting off and subsequently drying the board-shaped one, and cutting off the dried and shaped one into a product dimension, wherein the method further comprises the step of preliminarily adding a pore size adjusting agent for adjusting sizes of ~~foams~~pores formed by bubbles distributed in the foamed gypsum slurry to one of a stock solution of the foaming agent and a mixture of a stock solution of the foaming agent and water to obtain the foaming agent for producing ~~foams~~a foam having bubbles with pores with desired sizes.

[0014] In the method of manufacturing a weight-saved gypsum board, preferably, the pore size adjusting agent contains at least one substance selected from the group including agents for increasing sizes of ~~the foams~~pores formed by bubbles in the foamed gypsum slurry and agents for decreasing sizes of pores formed by bubbles ~~the foams~~ in the foamed gypsum slurry.

[0015] In the method of manufacturing a weight-saved gypsum board, preferably, the agent for increasing sizes of pores formed by bubbles ~~the foams~~ in the foamed gypsum slurry contains at least one substance selected from the group including water-soluble acidic substances, strong acids, and water-soluble strong alkaline substances.

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[0016] In the method of manufacturing a weight-saved gypsum board, preferably, the agent for increasing sizes of pores formed by bubbles ~~the foams~~ in the foamed gypsum slurry contains at least one substance selected from the group including aluminum sulfate, aluminum potassium sulfate, aluminum ammonium sulfate, ferric sulfate, polyferric sulfate, sulfuric acid, sulfamic acid, sodium hydroxide, and potassium hydroxide.

[0017] In the method of manufacturing a weight-saved gypsum board, preferably, the agent for decreasing sizes of pores formed by bubbles ~~the foams~~ in the foamed gypsum slurry contains at least one substance selected from the group including sulfosuccinate-type surface active agents, sarcosinate-type surface active agents, alkylbenzene sulfonate-type surface active agents, alkane sulfonate-type surface active agents, and alkylbetaine-type surface active agents.

In the specification, please amend ¶[0032] as follows:

[0032] In a method of manufacturing a weight-saved gypsum board according to the present invention, a method for producing a foam having bubbles of the desired size ~~foams~~ from a foaming agent may be a prefoaming method such that air is blown into a foaming agent and is not particularly limited. For implementing the prefoaming method, a mixing apparatus for mixing the ~~foams~~ foam having bubbles into the kneaded material has mainly a foaming agent accepting tank for accepting a foaming agent stock solution, a pump for pumping a certain amount of the foaming agent stock solution from the foaming agent accepting tank, a foaming apparatus for blowing pressurized air into the foaming agent stock solution pumped from the foaming agent accepting tank and stirring the mixture of the foaming agent stock solution and the air so as to produce ~~foams~~ a foam having bubbles from the foaming agent stock solution, and at least one pump for delivering the foams produced from the foaming agent stock solution into a kneaded material that contains a calcined gypsum and water.

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In the specification, please amend ¶[0035] as follows:

[0035] As the foaming apparatus, shearing force produced by high-speed stirring may be further applied to the foaming agent that is provided on the condition of a stock solution or an aqueous solution and produces foams using pressurized air. Alternatively, the foaming agent may pass through fine particulate beads so as to produce ~~foams~~ a foam having bubbles fully. In order to obtain a certain amount of foams by improving the quantitative precision for the foaming agent, the water, and the air, a publicly known flowmeter may be provided in the way of a pipeline for delivering each substance so as to control the rate of flow of each substance automatically.

In the specification, please amend ¶[0037] as follows:

[0037] In a method of manufacturing a weight-saved gypsum board according to the present invention, as described above, a foaming agent stock solution can be used as it is, and an aqueous solution of a foaming agent stock solution that is prepared by diluting the foaming agent stock solution with water preliminarily or just before the foaming can also be used. When the foaming agent stock solution is diluted with water, the dilution ratio for the foaming agent stock solution can be set arbitrarily and preferably is within a range of foaming agent stock solution:water=1:1 through 1:1000. If the dilution ratio is larger than the range, the stability of the foams significantly lowers, so that defoaming and foam-breaking occur in time of mixing the foam having bubbles ~~foams~~ into the kneaded material. As a result, it is difficult to distribute pores uniformly in an obtained gypsum core. On the other hand, if the dilution ratio is smaller than the range, the loading of the foaming agent stock solution is overabundant, so that pressure for delivering the foaming agent may not be enough and controlling the rate of flow of the foaming agent may be difficult. Additionally, in time of mixing the foam

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having bubbles foams into the kneaded material, a portion of defoamed or broken foams may foam up again. As a result, even if the pore size adjusting agent is added into the foaming agent, the sizes of the pores in the gypsum core cannot be adjusted.

In the specification, please amend ¶¶[0041]-[0043] as follows:

[0041] The pore size adjusting agents are preferably liquid or water-soluble solid. More preferably, the pore size adjusting agent is preliminarily obtained by mixing and diluting the agent with water. When the concentration of the aqueous solution of the pore size adjusting agent is too high, even if a small amount of the aqueous solution is added into the foaming agent, the changes of the sizes of pores formed by bubbles foams obtained in the foaming apparatus are too large. As a result, the size of pores in a finally obtained gypsum core become too large or too small. Additionally, it becomes very difficult to control the rate of flow of the aqueous solution of the pore size adjusting agent. On the other hand, when the concentration of the aqueous solution of the pore size adjusting agent is too low, the amount of water added into the foaming agent preliminarily or just before the foaming can be adjusted to some extent. However, the amount of water that is directly kneaded with the calcined gypsum is reduced. When the aqueous solution of the pore size adjusting agent is prepared, the concentration of the aqueous solution of the pore size adjusting agent is 10% by weight through 80% by weight, preferably 20% by weight through 70% by weight.

[0042] In a method of manufacturing a weight-saved gypsum board according to the present invention, just before producing a foam having bubbles of the desired pore size foams from the foaming agent, a pore size adjusting agent is poured into a pipeline for delivering the foaming agent stock solution or the aqueous solution of the foaming agent stock solution. For the pour of the pore size adjusting agent, provided are a pore size adjusting agent accepting tank for accepting a pore size adjusting agent, if necessary, a pore size adjusting agent

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diluting and dissolving tank for diluting the pore size adjusting agent with water, and a pump for pumping the pore size adjusting agent from the pore size adjusting agent diluting and dissolving tank, etc. Such equipment is used to pour the aqueous solution of the pore size adjusting agent into the foaming agent or into the aqueous solution of the foaming agent delivered through the pipeline. Furthermore, a tube-type mixing apparatus such as a static mixer may be provided on a pipeline portion between the foaming apparatus and the position at which the pore size adjusting agent is poured into the foaming agent stock solution or the aqueous solution of the foaming agent stock solution. In order to keep the loading of the pore size adjusting agent constant, the rate of flow of the pore size adjusting agent may be automatically controlled using a publicly known flowmeter similar to the flowmeter for the foaming agent.

[0043] In a method of manufacturing a weight-saved gypsum board according to the present invention, just before producing a foam having bubbles with the desired sizes foams from the foaming agent, the sizes of pores formed by bubbles foams in the foamed gypsum slurry can be easily controlled by adjusting the loading(s) of the agent for increasing the foam sizes and/or the agent for decreasing the foam sizes to the foaming agent independently or in combination. Each of the pore size adjusting agents can be added into the foaming agent independently, in compliance with desired conditions for foams in the obtained foamed gypsum slurry, particularly, desired sizes of the foams. Additionally, a multiple of the pore size adjusting agents can be used in combination and each of the loadings of the pore size adjusting agents can also be adjusted. The loadings of the pore size adjusting agents are not particularly limited, and can be set generally in the range of 0.00001 parts by weight through 0.005 parts by weight, preferably in the range of 0.0005 parts by weight through 0.003 parts by weight, per 100 parts by weight of calcined gypsum, regardless of the case of adding the pore size adjusting agent independently or the case of using a multiple of the pore size adjusting agents in combination.

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In the specification, please amend ¶[0045] as follows:

[0045] Thus, the mixture (as the foaming agent) of the pore size adjusting agents and the foaming agent stock solution or the aqueous solution of the foaming agent stock solution is delivered into the foaming apparatus and air is injected into the flow of the foaming agent so as to produce ~~foams~~ a foam having bubbles from the foaming agent.

In the specification, please amend ¶[0047] as follows:

[0047] When a method of manufacturing a weight-saved gypsum board according to the present invention is implemented, just before shaping the foamed gypsum slurry obtained as described above into a board shape in a shaping machine, it is desirable to sample and harden the foamed gypsum slurry regularly so as to obtain a harden foamed gypsum and to confirm the conditions of pores, particularly pore sizes, in a fracture plane of the hardened foamed gypsum. In order to confirm the condition of the pores in the hardened foamed gypsum, a fracture plane of the hardened foamed gypsum may be observed by visual observation or by using a magnifier so as to judge whether or not the pores with the desired sizes are formed. Also, whether or not the pores with the desired sizes are formed may be judged by using a publicly known method in which a fracture plane of the hardened foamed gypsum is subjected to skew rays and lights and darks of an image on an arbitrary straight line or a predetermined section within a visual field using an imaging device such as a CCD camera. If the sizes of pores formed by bubbles ~~foams~~ in the foamed gypsum slurry are too small or smaller than a desired size range, the loading of the agent for increasing the foam sizes is increased within the range for the loading. If the sizes of pores formed by bubbles ~~foams~~ in the foamed gypsum slurry are too large or larger than the desired size range, the agent for decreasing the foam sizes is similarly increased. Accordingly, the sizes of pores formed by bubbles ~~foams~~ in the foamed gypsum slurry can be adjusted timely and in a short time.

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In the specification, please amend ¶[0049] as follows:

[0049] When aluminum sulfate is used as the pore size adjusting agent by adding and mixing it into a foaming agent just before producing a foam having bubbles with the desired sizes~~foams~~ from the foaming agent, the loading of it can be significantly reduced compared to the loading of it as a foam stabilizer used in the conventional ways of adding and mixing it into gypsum slurry directly, and consequently, the production cost for a weight-saved gypsum board product can also be reduced.

In the specification, please amend ¶[0081] as follows:

[0081] A weight-saved gypsum board with a thickness of 12.5 mm (a width of 910 mm, a length of 1820 mm, and a density of 0.65 g/cm³) was manufactured similar to reference 1 except adding 0.0005 parts by weight of aluminum sulfate as a pore size adjusting agent for increasing the size of ~~foams~~pores formed by bubbles in the foamed gypsum slurry per 100 parts by weight of the calcined gypsum into the aqueous solution of the foaming agent stock solution, and blowing air into the aqueous solution of the foaming agent stock solution that contains aluminum sulfate so as to produce ~~foams~~a foam having bubbles with the desired pore size. Also, one of the manufactured weight-saved gypsum boards was randomly sampled and tests similar to those of reference 1 were performed. The results are shown in FIG. 2 and Table 1.

In the specification, please amend ¶[0083] as follows:

[0083] A weight-saved gypsum board with a thickness of 12.5 mm (a width of 910 mm, a length of 1820 mm, and a density of 0.65 g/cm³) was manufactured similar to reference 1 except adding 0.005 parts by weight of aluminum sulfate as a pore size adjusting agent for increasing the size of foams in the foamed gypsum slurry per 100 parts by weight of the calcined gypsum into the aqueous

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solution of the foaming agent stock solution, and blowing air into the aqueous solution of the foaming agent stock solution that contains aluminum sulfate so as to produce ~~foams~~a foam having bubbles. Also, one of the manufactured weight-saved gypsum boards was randomly sampled and tests similar to those of reference 1 were performed. The results are shown in FIG. 3 and Table 1.

In the specification, please amend ¶[0085] as follows:

[0085] A weight-saved gypsum board with a thickness of 12.5 mm (a width of 910 mm, a length of 1820 mm, and a density of 0.65 g/cm³) was manufactured similar to reference 1 except adding 0.003 parts by weight of the sulfosuccinate-type surface active agent as a pore size adjusting agent for decreasing the size of ~~foams~~pores formed by bubbles in the foamed gypsum slurry per 100 parts by weight of the calcined gypsum into the aqueous solution of the foaming agent stock solution, and blowing air into the aqueous solution of the foaming agent stock solution that contains the sulfosuccinate-type surface active agent so as to produce ~~foams~~a foam having bubbles. Also, one of the manufactured weight-saved gypsum boards was randomly sampled and tests similar to those of reference 1 were performed. The results are shown in FIG. 4 and Table 1.

In the specification, please amend ¶[0094] as follows:

[0094] A weight-saved gypsum board with a thickness of 12.5 mm (a width of 910 mm, a length of 1820 mm, and a density of 0.65 g/cm³) was manufactured similar to reference 2 except adding 0.0005 parts by weight of aluminum sulfate as a pore size adjusting agent for increasing the size of ~~foams~~pores formed by bubbles in the foamed gypsum slurry per 100 parts by weight of the calcined gypsum into the aqueous solution of the foaming agent stock solution, and blowing air into the aqueous solution of the foaming agent stock solution that contains aluminum sulfate so as to produce ~~foams~~a foam having bubbles. Also, one of the manufactured weight-saved gypsum boards was randomly sampled

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and tests similar to those of reference 1 were performed. The results are shown in FIG. 7 and Table 1.

In the specification, please amend ¶[0096] as follows:

[0096] According to the conventional technique claimed in claim 12 in Japanese Patent No. 3028123, alkyl sulfate having the chemical formula represented in the claim was diluted with water so as to prepare an aqueous solution. Then, air was blown into the prepared aqueous solution so as to produce ~~foams~~ a foam having bubbles with a form density of 0.205 g/cm.^{sup.3} The produced foams were added and mixed into gypsum slurry fractionated from the slurry extracting part using a method similar to Example 1 so as to obtain foamed gypsum slurry. The foamed gypsum slurry was poured into a space between a front-side and a back-side base papers for gypsum board so as to manufacture a board-shaped and weight-saved gypsum board with a thickness of 12.5 mm (a width of 910 mm, a length of 1820 mm, and a density of 0.65 g/cm.^{sup.3}). Also, one of the manufactured weight-saved gypsum boards was randomly sampled and tests similar to those of reference 1 were performed. The results are shown in FIG. 8 and Table 1.